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To address the NPIC management information problem in detail, it is essential to provide a practical framework comprising definitions of certain terms and pertinent concepts concerning the management process, management information systems, and planning and control or command and control. This appendix, which deals with these topics, is divided into four sections. The first, Definition of Planning, Control, and Management Information, is essential to the Main Report since the terms defined are used throughout. The second, third, and fourth sections, Strategic Planning versus Management Control, Management Control versus Operational Control, and Systems Design Implications, respectively, are presented, firstly, in amplification of the definitions and to show their inter-relationships and, secondly, to present pertinent generalizations about a management information system based upon the discussions in the first three sections.

Definition of Planning, Control,
and Management Information

The central function of management, its raison d'etre, is decision-making. Except for a relatively straightforward class of decisions readily amenable to operations research (OR) or purely mathematical solution, where enough of the decision variables can be rather explicitly quantified (e.g.; inventory control, resource allocation of the assignment and distribution type, replacement, maintenance, and reliability problems, sequencing and coordination problems--PERT and CPM, routing problems, etc.), decision-making not only involves but depends upon human judgment. Judgment can be enhanced by good information; this is the sole purpose of a management information system--to inform management of the facts available relevant to the decision at hand. Therefore, a management information system is not a substitute for, but only an aid to, management, as the name implies. As a corollary, the "perfect" information system would be of little overall value to the organization, if management were not competent.

These simple and what might appear to be quite obvious facts are often overlooked, consciously or unconsciously, by those involved with automated information systems, whether it be in their design, implementation, operation, or evaluation. That is, no matter how effective, an information system does not automatically produce good decisions. Unfortunately, automated information systems along with OR and systems

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analysis techniques, are often "sold," either openly or implicitly, as universal remedies for any and all management problems. Nothing could be further from the truth.

These facts are pointed out not in denigration of OR, systems analysis, or information specialists, or the usefulness of their skills and products. These disciplines are not only worthwhile, but are even essential, in today's environment; the intent is to put them in proper perspective, which often is not done. For example, an OR specialist worth his salt will openly state that OR techniques are applicable only to a certain class of problems and not necessarily to management problems in general; the good ones will not attempt to apply techniques where they do not belong--the "solution looking for a problem" approach with which many of us are all too familiar. (OR techniques are most applicable to that class of decisions which falls under the management function of operational control, as is discussed below.) Likewise, a competent systems analyst will stress emphatically that systems analysis is an aid to decision-making (generally at the other end of the management spectrum from OR-type problems); systems analysis does not make decisions. An analogous statement could be made concerning automated information systems and those specialists dealing with them.

Coupled with the pervasive lack of attention to the principal purpose of a management information system--an aid to management--often is the failure to provide a meaningful, practical framework for consideration of the information problem, both of which auger against worthwhile automated systems and often insure their failure. That is, not only is the basic purpose of the system not made explicit, but the very process which the system is intended to facilitate, the management process, is also neglected.

It is fine to talk of planning and control or command and control systems because conceptually these classifications have validity; however, under careful consideration and particularly when applied to real-world problems, such broad classifications of management activity are of little value. In fact, they often cloud rather than aid the issue. This is because planning or command (roughly, determining what is to be done) and control (roughly insuring that to be done is done) do not correspond to distinct, separable management activities either with respect to time, organizational position or authority, or various discrete issues or problems.

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For example, many persons in an organization engage in planning; but its basic purposes and nature vary so significantly that any generalizations valid to encompass all types of planning within an organization are so vague and broad that they are of little help in solutions of practical problems. A similar statement can be made for the control activity which involves, among other things, decision-making. The basic steps in the annual Congressional Budget, simplified for this example, illustrate these facts. The cycle starts with preparation and approval at the appropriate time of the Congressional Budget, which is clearly a planning activity. However, the budget is also used as a basis for control (many say budget preparation is the principal means of achieving control), and during the budget year, many activities occur that clearly pertain to control while, simultaneously and as part of the same process, there may be budget revision, which is a planning activity. In short, planning and control activities are so closely interwoven in the budgeting process that to describe each separately is not only difficult but also pointless, because those involved with the process are interested in both its planning aspect and its control aspect.

As with the budgetary example, planning or command and control in general are, in fact, so closely interwoven, especially outside the military, and so often occur simultaneously that there is nothing to be gained from such distinctions. A more realistic and useful framework for considering the NPIC management information problem, along with the necessary definitions, is given below.

Strategic Planning: the process of deciding on objectives of the organization, on changes in these objectives, on the gross resources used to attain these objectives, and on the policies that are to govern the acquisition and use of these resources. (Systems analysis is most applicable here.)

Management Control: the process by which managers assure that resources are obtained and used effectively and efficiently in the accomplishment of the organization's objectives. It combines both planning and control within the context of objectives and policies determined in the strategic planning process; effectiveness and efficiency are the criteria relevant for judging actions. Decisions in this process can

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be categorized as non-programmed; management decides what is to be done within the general constraints of the strategic plans. (Long-range planning, conceptually quite distinct from strategic planning, is applicable to this process.)

Operational Control: the process of assuring that specific tasks are carried out efficiently and effectively. Decisions in this process often can be categorized as programmed or structured, as opposed to management control decisions; emphasis is upon execution of tasks. (Operations research has its greatest utility in this process.)

Strategic Planning versus Management Control

Strategic planning highlights objectives, which are what the organization wishes to accomplish or its mission, and policies, which are guidelines to be used in the choice of the most appropriate courses of action to achieve the objectives. This type of planning is concerned with plans and policies which determine or change the character or direction of the organization; such decisions affect the physical, financial, and organizational framework within which operations are conducted.

Management control incorporates the concepts of effectiveness and efficiency, effectiveness referring to the accomplishment of the organization's objectives and efficiency referring to an optimum relationship between input and output. It should be noted that management control embraces both planning and control, and the usual connotation given control; that is, conformance to plan, is missing. This is intentional, because to the extent that middle management can make decisions better than those implied in a plan, it should do so. Therefore, top management should not necessarily want operations to conform to plans, and rigid conformance to plans is not the standard against which performance should be measured. However, plans should be followed in the absence of evidence to the contrary.

The management control process is carried on within the guidelines established by strategic planning; its intent is to make possible the attainment of planned objectives as effectively and efficiently as possible within given constraints. This process involves making decisions about what to do in the future (the usual interpretation of planning), but the

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planning decisions made in the management control process are of a somewhat different character from those made in the strategic planning process, although the dividing line may at times be fuzzy and certainly there are interactions between the two processes.

A main distinction lies in the fact that management control relates to current operations while strategic planning relates to objectives, policies, organizational structure, etc. Also, strategic planning involves a preponderance of value judgments while management control decisions involve a preponderance of facts. Management control is less complex than strategic planning, since it does not set but only works within precedents; that is, policies and plans already decided upon. In addition, it tends to be rhythmic; e.g., the budgeting process, while strategic planning is essentially irregular because problems, opportunities, good ideas, and technological breakthroughs do not occur according to a timetable and there is no essential condition to cumulate strategic plans and present them in a nice, neat package on a specific date.

Management control systems, with rare exceptions, have an underlying financial structure; that is, plans and results expressed in monetary units; for example, as in the PPB system. This does not mean that money is the only basis for measurement, however, or even that it is the most important measure; it does mean that money is a common denominator to relate various pieces to one another, although other measurements such as manpower, product output, timeliness, etc., may be essential, as well as certain non-qualitative attributes such as quality, ability, cooperation, etc.

Management control systems should be integrated, coordinated systems which means that, although data collected for one purpose may differ from that collected for other purposes, these data should all be reconcilable with one another, or equivalently that non-monetary information should be reconcilable with monetary information. For example, information on the number of personnel must be relatable to information on the cost of personnel. While strategic planning data often is "one-shot" and can rely heavily on external information, a good deal of which may be relatively imprecise, management control data have the same definitions and are put together in the same way time after time. These data are intended to influence line managers to take actions that will lead to desired results; management control decisions are made by the line, not the staff.

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In contrast, the data relevant for strategic planning purposes are put together specifically for decision concerning a particular plan. The estimates used in strategic planning are intended to show the expected results of the plan. This usually predominately staff function, carried on in consort with line management, can best be characterized as creative as opposed to management control which is exercising leadership, even though the organizational distinction may not be clear-cut. The only control aspects of strategic planning, if they may be called that, have to do with the top management need to check on the progress being made by the staff toward arriving at a decision on a problem being analyzed, to appraise the ability of those involved in the process, and to determine whether general policies are being followed in the implementation of procedures. And it should be pointed out that the PPB five-year plan, the PFP, is actually an exercise in management control because the plan itself is a projection of costs anticipated under policies and programs already approved, rather than a device for consideration of and decision on new policies and programs; this function is accomplished through the Program Memoranda. The PFP reflects strategic decisions already taken; it is not the essence of the process of making new decisions.

It is because of the varied and unpredictable nature of data required for strategic planning that an attempt to design an all - purpose, internal information system is probably hopeless. For the same reason, the dream of some computer specialists of a gigantic data bank, from which planners can obtain all the information they wish by flicking a switch, is probably no more than a dream. However, conceptually at least, a management control system should be a single system, or an integrated set of subsystems. In practice, attainment of this goal of "integrated data processing" is so fantastically complicated even for a moderate size organization that few, if any, organizations would even claim its achievement. Nevertheless, this is the goal, and those interested in improving management control systems will work toward it. The error arises in attempts to meet the needs for strategic planning data from the same system; the data needed to plan and control ongoing activities are quite different from those needed to analyze proposed major changes in operations. To ask that data be collected routinely in elemental building blocks that can be combined in various ways to answer all conceivable questions is a completely unrealistic request

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since no one can foresee the possible ways in which data might be used, and even if foreseen, some of the uses occur so infrequently that the routine collection of data for them is not economically justified.

Management Control versus Operational Control

As with strategic planning and management control, the distinction between management control and operational control is not always precise. Operational control takes place within the context of decisions made and rules formulated in the management control process and to some extent in the strategic planning process, and overall performance in activities where operational control is applicable is reviewed as part of the management control process. As indicated, the focus of operational control is upon specific tasks or transactions: scheduling and monitoring and not measuring overall performance; obtaining certain equipment and not managing inventory; personnel actions and not determining personnel policy, etc.

Outputs are the products, services, or other effects created by an organization; inputs are the resources the organization consumes. Outputs, in every case, many not being clearly definable or readily measurable. In addition to the overall organization's outputs, every unit within an organization has outputs, either products or services or combinations thereof, which again may be difficult to measure.

One of the important management tasks in an organization is to seek the optimum relationship between inputs and outputs; that is, either the best combination of outputs when inputs can be varied or the combination of resources that will produce the desired outputs at the lowest costs in an environment where the desired outputs are taken as given. Of course, there may be gradations of the above, wherein there are varying degrees of latitude between given outputs and variation of inputs; that is, each may be varied to a certain extent, but there are real constraints. When there is the option of varying inputs, it is rarely, if ever, possible to determine the optimum relationship between outputs and inputs objectively, in spite of many opinions to the contrary. This choice of a relationship is a matter of subjective judgment, and this is true because, generally, there is no scientific or objective way of determining how final output will be affected by changes in inputs or necessarily what is the "best" output mix, especially where it comprises services. However,

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if output is taken as given, then there is at least the possibility that an optimum relationship between outputs and inputs can be found, but perhaps not absolutely since new ways of doing things are continually being developed. Therefore, optimum in this case must mean that combination of resources, out of all known combinations, that will produce the desired output at the lowest cost. For some activities, the optimum relationship may be rather easy to determine; for others, there exists no way of establishing the relationship, and again, decisions as to what costs to incur depend upon human judgment. In the latter case, the term overhead roughly corresponds to this class of inputs or costs.

It should be noted that the importance of the input-output relationship can be overemphasized. Decisions in this area should be weighed very carefully. For example, conflicts between input-output objectives and organizational goals can arise; that is, large increases in economy, efficiency, or productivity may be possible only at the costs of dissatisfactions to some employees and even external groups, curtailments in output quality which may be very difficult to measure, dissipation of organizational assets, etc. However, with this caveat in mind, if the optimum input-output relationship can be determined for a given activity, the inputs that should be employed in a given set of circumstances can be described and reduced to rules; that is, they can be programmed. These are the activities for which programmed operational control is applicable, and as new techniques are developed, there is a tendency for more and more activities to be susceptible to programmed control. But operational control and programmed control are not synonymous, for there are many, in fact a preponderance of, specific tasks that cannot be explicitly programmed; for example, certain research tasks as might be undertaken by the PSG/R&RD, special studies performed by staff officers, analysis of new types of targets or very significant "finds" or changes in known targets, the entire class of activities often referred to as overhead, etc.

To make the distinction between management control and operational control clear, management control focuses upon the whole stream of on-going activities while operational control focuses upon individual tasks or transactions. Just as management control occurs within a set of policies derived from strategic planning, operational control occurs within a set of well-defined procedures and rules that are derived from both strategic planning and management control.

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An operational control system is a rational system; that is, in general, the action to be taken is decided by a set of logical rules, which may or may not cover all aspects of a given problem. Situations not covered by rules are exceptions and are handled by human judgment, but other than these exceptions, the rules are applied automatically. In management control psychological considerations are dominant. The management control system at most assists those who take action; it does not directly or by itself result in action without human intervention. A management control system is ordinarily built around a financial core; operational control data are often non-monetary. Data in an operational control system are in real-time and relate to individual events, whereas data in a management control system are either prospective or retrospective and summarize many separate events.

Computer specialists and even managers who do not make a proper distinction between management and operational control dream about a system that will display to management the current status of every project and activity within the organization. Although theoretically this could be done, it should not be done, because management does not want, or should not want, such detail. It does not need to know when project 112076NA was transferred from the PI to the editor; rather, it needs to know only that the process is, or is not, proceeding as planned. That is, information shows up in the management control system only when it is exceptional, when a situation arises that is not covered by the rules included in the operational control system or when there is a significant departure from those rules. Some means of calling these exceptional situations to management's attention are essential, and this is the interface between operational and management control.

Operational control uses exact data, whereas management control needs only approximations. The formal management control system is only one aspect of the management control process, actually a relatively unimportant aspect. The system can help motivate a manager to make decisions in the best interests of the organization and the system provides information that aids the manager in making these decisions. The success or failure of the management control process depends upon the personal characteristics of the manager: his judgment, his knowledge, his ability to influence others. The distinction between the system and the process is apparent in such comments as "We are bogged down in red tape" or "Paperwork keeps me from getting the job done." Such comments are symptoms that the system is impeding the proper

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functioning of the management control process. While in operational control, the system itself is a much more important aspect of the whole process, it is not the entire process unless the system is automated, but it ordinarily states what action should be taken. With a properly designed system, operational control will require a minimum of management intervention; the degree of management involvement in operational control will be small, directed toward exceptions.

Systems Design Implications

Some generalizations for systems design of what is often called a planning and control system, can be drawn from the preceding discussion. First, it seems clear that the starting point is construction of the overall system should be management control, as distinguished from strategic planning and operational control. The management control system deals with the ongoing operation of the entire organization. It must encompass all parts of the enterprise so as to assist management in determining that the parts are in balance with one another. The central function of a management control system is motivation; the system should be designed in such a way that it assists and guides operating management to make decisions and to act in ways that are consistent with the overall organizational objectives.

Strategic planning, management control, and operational control tend to correspond to a hierarchy in any of several dimensions: as to time-span of consequences (long range, medium range, day-to-day); as to level in the organization (top management, top and operating management, supervision); as to importance of a single action (major importance, medium importance, little importance); as to amount of judgment involved (great, some, none), and so on. Along each of these continuums, management control is in the middle.

Second, although the management control system is the logical starting point, its relationship to the other systems should be recognized. The management control system can be designed so as to take into account the more important needs of the strategic planners, for current and historical operating information, but it cannot possibly foresee all these needs, nor would it be worthwhile to supply routinely information that is needed only occasionally, even if the need could be foreseen.

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Management control also takes information from areas where operational control devices are used, but the coupling between the two need not be too tight. Operational control usually involves a tremendous amount of detail, and all that should be needed for management control purposes is a way of summarizing and translating this detail so as to show that operations are proceeding satisfactorily, or, if they are not, where the trouble spots are.

Third, if management control is the system around which others are to be constructed, then it is clear that the central system must be a financial system. Money is the only common denominator for bringing together heterogeneous elements of outputs and inputs that are the concern of management.

Finally, computers and models cannot be the essence of this central system. In management control, the judgment and feelings of human beings are dominant (to ignore this can be catastrophic); in computers, they are necessarily absent. In strategic planning, an organization-wide model can be a valuable tool for examining repercussions of proposed strategic moves throughout the organization. In operational control, models for specific areas being controlled may be essential, and computers can often be used. These observations suggest that, because management control is central, integrated data processing should be focused on needs of management control. It should not be much concerned with problems of strategic planning in view of the irregular, nonrecurring, and unpredictable character of these problems. It should be linked to operational control procedures, as these are developed, but an integrated data processing system need not await the installation of all possible operational control procedures.

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